



Environmental quality assessment in an urban residential cluster around a wastewater body (*Ginani*) in Sardarshahar, Rajasthan: A questionnaire-based study

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Abstract

Urban wastewater bodies remain a significant environmental concern in rapidly growing Indian cities, where nearby residential areas often experience degraded living conditions and sanitation stress. This study examines environmental quality in an urban residential cluster adjacent to a wastewater body in Sardarshahar, Rajasthan, using a structured questionnaire survey. Residents evaluated air quality, road quality, drainage system efficiency and water quality across four distance bands from the wastewater source: <100 m, 100–200 m, 200–300 m, and >300 m. The results indicate that environmental quality worsens closer to the wastewater body, especially in terms of drainage and air quality and improves with increasing distance. These findings support the need for stronger sanitation planning and local environmental monitoring to reduce public health risks.

Keywords: Wastewater impact, residential cluster, urban sanitation, Sardarshahar

Introduction

Urban environmental quality has become a major concern in rapidly expanding settlements, particularly where residential areas are adjacent to poorly managed wastewater bodies, open drains, stagnant water and inadequate sewerage infrastructure. Wastewater bodies located within or near residential clusters can affect air and water quality, drainage efficiency, road conditions, odour levels, mosquito breeding and public health. Globally, progress toward Sustainable Development Goal 6 (Clean Water and Sanitation) remains off-track, highlighting the need for improved wastewater management and local-level environmental monitoring (UN-Water, 2023; World Health Organization [WHO], 2024) [25, 28]. Poor sanitation has been linked to diseases such as diarrhoea, cholera, dysentery, typhoid, intestinal worm infections and wider social and economic impacts (WHO, 2024) [28].

In India, rapid urban expansion has increased pressure on wastewater infrastructure. As per CPCB report, urban areas generate approximately 72,368 million litres per day (MLD) of sewage, while the installed treatment capacity is only about 31,841 MLD (Central Pollution Control Board (Ministry of Jal Shakti, 2021) [14]. Consequently, untreated or partially treated wastewater often enters drains, ponds, rivers and low-lying urban areas. Effective wastewater management depends not only on treatment plants but also on sewer networks, drainage systems, household wastewater disposal and regular maintenance (Ministry of Housing and Urban Affairs [MoHUA], 2013) [13]. Poorly maintained drainage systems can result in stagnation, overflow, foul odour and deterioration of the surrounding environment. As a result, many towns experience pollution risks, poor drainage and declining neighbourhood quality, particularly where treatment systems are inadequate (NITI Aayog, 2022; Qadir *et al.*, 2020) [16, 18].

Rajasthan provides a particularly important setting for such studies because of its arid and semi-arid conditions, limited surface-water resources and growing urban population.

Despite covering about 10% of India's land area, the state possesses only around 1% of the country's surface-water resources (Asian Development Bank [ADB], 2020, 2026) [1, 2]. In secondary towns such as Sardarshahar, wastewater is often managed through low-cost containment systems, including open storage ponds or stabilization basins. These ponds, frequently unlined and uncovered, function as repositories for municipal wastewater with limited treatment and monitoring (National Institute of Urban Affairs [NIUA], 2019) [15]. Their proximity to residential areas may influence residents' perceptions of environmental quality and neighbourhood liveability.

Residents' perceptions provide valuable insights into environmental conditions that may not be evident from infrastructure data alone (Creswell & Creswell, 2018) [6]. Studies have shown that people living near urban water bodies are highly aware of problems such as water pollution, foul odour, visual degradation, insects and poor environmental management (Kenanoğlu *et al.*, 2024) [10]. Subjective assessments are often shaped by visible and sensory indicators, including smell, turbidity and aesthetic quality (Steinwender *et al.*, 2008) [20], while perception surveys have been successfully used to evaluate environmental improvements and community awareness (Faulkner *et al.*, 2001) [7]. Odour, in particular, is an important factor influencing perceptions of environmental quality around polluted water bodies (Sado-Inamura & Fukushi, 2018) [19]. In residential settings, unpleasant smells from stagnant wastewater are often interpreted as poor air quality, demonstrating the close relationship between wastewater management, drainage conditions, and environmental perception.

The present study examines whether residents' perceptions of environmental quality vary with distance from the wastewater body locally called *ginani*. Using a questionnaire-based survey, the study assesses four indicators - air quality, water quality, drainage condition and

road quality, which represent key sensory and functional dimensions of the residential environment. Households are grouped into distance bands from the wastewater body to evaluate whether environmental-quality ratings change spatially with increasing distance from the source.

The study is significant because it focuses on a local wastewater body within a secondary-town residential setting, an area that remains relatively underrepresented in urban environmental research. By linking residents' perceptions with wastewater-body proximity and neighbourhood infrastructure conditions, the findings can provide useful evidence for municipal planning, drainage improvement, wastewater management, public-health

awareness, and local environmental monitoring in towns such as Sardarshahar.

Materials and Methods

Study Area

The investigation was carried out in an urban residential cluster adjacent to a wastewater body in Sardarshahar, Rajasthan. This covered ward numbers 4, 5, 8 and 10, residing near the wastewater body (Location: *Ginani Bas*; 28°25'59.87" N 74°29'02.66" E). The area was selected because households were located at different distances from the wastewater source, allowing spatial comparison of environmental perceptions.



Fig 1: Google image showing location of the wastewater body (WSP1) and surrounding households (source- Google Earth Pro (7.3.6.10201))

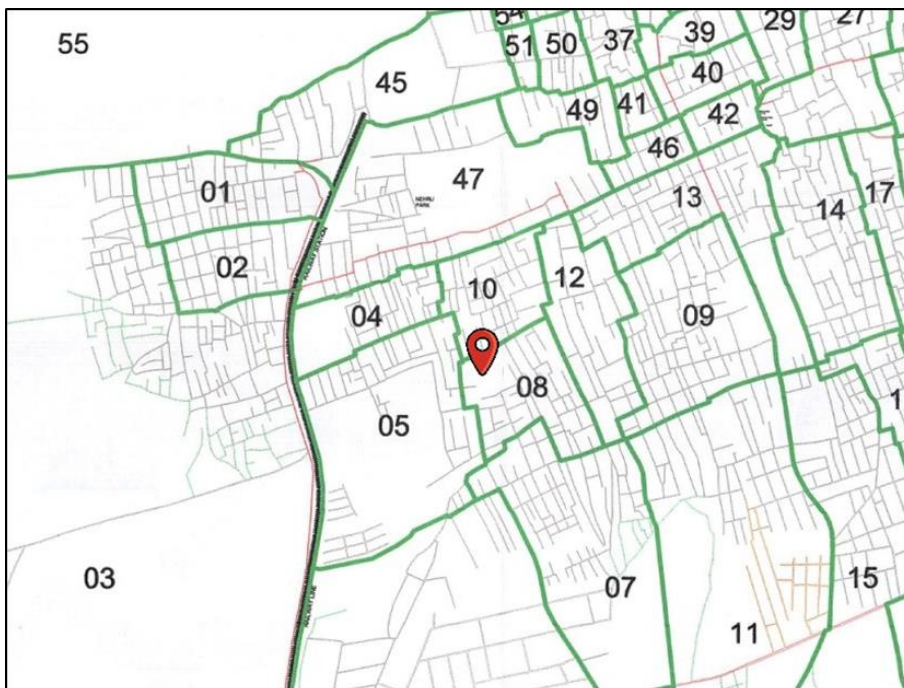


Fig 2: A map showing wastewater body (red icon) and surrounding localities (ward numbers) (Source- Nagar Palika, Sardarshahar)

Data Collection

A structured questionnaire was administered to residents in *ginani* area during year 2024-25. The questionnaire collected residents' perceptions of four environmental parameters: air quality, water quality, road quality, and drainage system efficiency. Responses were recorded on a five-point scale from Very Bad to Very Good. Households were grouped into four bands according to distance from the wastewater body: <100 m, 100–200 m, 200–300 m, and >300 m (Creswell & Creswell, 2018; Field, 2018) [6, 9]. A total of 113 responses were recorded, with respondents' ages ranging from 18 to 78 years.

Data Analysis

Mean scores were calculated for each parameter by distance band. Chi-square tests were applied to assess whether environmental ratings differed significantly across distance categories, with significance set at $p < 0.05$ (Field, 2018) [9].

Results

Mean Scores by Distance Band

Air quality showed a gradual improvement with increasing distance from the wastewater body. Drainage also improved in the farthest zone, while road quality showed less regular variation. Water quality was almost stable.

Table 1: Mean scores of environmental parameters across distance bands

Distance band (score)	Air quality mean	Road quality mean	Drainage system mean	Water quality mean
<100 m	1.27	2.4	1.58	2.36
100–200 m	1.39	2.5	1.33	2.44
200–300 m	1.59	2.18	1.76	2.53
>300 m	1.84	2.58	2.29	2.53

Questionnaire Response Distribution

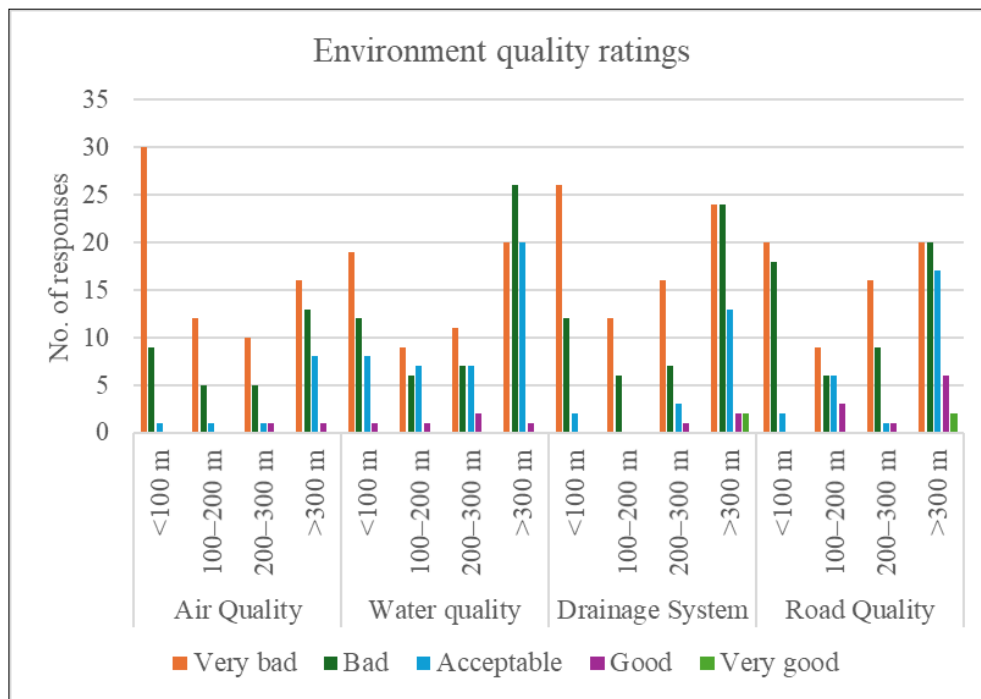


Fig 3: Summary of survey responses across distance bands

Statistical Analysis

The chi-square result indicated a significant association between distance and drainage perception ($P < 0.01$). All other perceptions were found to be non-significant ($p < 0.05$)

- **Air quality vs distance:** $\chi^2=15.15$, $df = 9$, $p = 0.087$ (not significant).
- **Road quality vs distance:** $\chi^2=12.63$, $df = 9$, $p = 0.180$ (not significant).
- **Drainage system vs distance:** $\chi^2=24.68$, $df = 9$, $p = 0.003$ (significant association).
- **Water quality vs distance:** $\chi^2=5.11$, $df = 9$, $p = 0.825$ (not significant).

Discussion

Spatial Variation in Environmental Quality

The survey results show a clear spatial gradient in environmental quality across distance bands from the

wastewater body. The pattern indicates that people living closer to wastewater bodies perceive environmental conditions as more serious, especially air quality and drainage (Qadir *et al.*, 2020; WHO, 2021) [18, 26]. These perceptions may result from odour, stagnation, and poor runoff management. Air quality improved gradually with distance due to dilution and atmospheric dispersion of volatile organic compounds (VOCs) and odours emitted from wastewater (Ukaigwe *et al.*, 2025) [22].

Key Findings by Parameter

Drainage system showed the strongest distance relationship ($p=0.003$), with scores improving substantially from 1.58 to 2.29. This confirms that drainage infrastructure near wastewater bodies is compromised by flooding and effluent overflow. The same holds true in Indian cities where wastewater treatment is still inadequate, and impoverished

settlements face poor environmental quality (CPCB, 2021a; UN-Habitat, 2020) [3]. Areas within 300 m require immediate drainage upgrades.

Air quality showed progressive improvement but was not statistically significant ($p=0.087$), likely due to other pollution sources (traffic, industry) masking wastewater-specific effects (Choi & Ready, 2026) [5].

Water quality improved modestly (from 2.36 to 2.53) but was non-significant ($p=0.825$). This contrasts with studies showing significant improvements in water quality with increasing distance (Ukaigwe *et al.*, 2025) [22].

Road quality showed irregular variation, reflecting municipal infrastructure decisions rather than wastewater proximity.

Implications for Environmental Management

The findings have important implications for environmental planning in urban India:

- 1. Priority zone for drainage improvement:** Areas within 300 m require immediate drainage infrastructure upgrades, given the significant association between distance and drainage quality (CPCB, 2021a) [3].
- 2. Air quality monitoring:** While air quality showed improvement with distance, the non-significant result warrants expanded monitoring to identify other pollution sources (WHO, 2021) [26].
- 3. Integrated infrastructure approach:** Road quality irregularities indicate need for coordinated municipal planning beyond wastewater-specific interventions (UN-Habitat, 2020) [24].

Future studies should combine perception surveys with objective environmental measurements (water quality indices, air quality indices) to strengthen conclusions (Creswell & Creswell, 2018; Ukaigwe *et al.*, 2025) [6, 22].

Conclusion

The study highlights that proximity to the wastewater body is associated with perceived environmental quality; maintaining improved drainage, sewage management, and restoring environmental observation should be prioritised as essential actions in the considered area. Surveys that incorporate both community perception and objective environmental evaluation would provide a stronger basis for local planning and public health action.

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